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(54) DISPLAY DEVICE

(57)Abstract:

PURPOSE: To draw out the cooling capacity of a cooling fan to the max. extent by forming a pedestal to a shape having a vent hole for converging the wind of the cooling fan and providing a wind guide structure to a guide plate.

CONSTITUTION: The pedestal 8 has the vent hole 9R in the relative position with the wind guide structure 10R in the upper part thereof to converge the wind generated by the cooling fan 7 to the vent hole 9R. The wind converted to the hole 9R is divided to the wind blown right upward and the wind trying to escape to the outside from the center of rotation of the fan 7. The former passes the spacing between a liquid crystal light valve 3R and an exit side polarizing plate 13R and the spacing between the light valve 3R and an incident side polarizing plate 12R to deprive the polarizing plates 12R, 13R of the surface heat thereof and blows by to the upper part from the hole provided to an upper plate 14. The latter is changed in the direction toward the polarizing plate 12R by the wind guide structure 10R provided to the guide plate 6R and passes a window 15R for incidence at the center of the guide plate 6R to deprive the polarizing plate 12R of the surface

heat thereof. This wind is changed in the direction by the polarizing plate 12R and is blown by to the outside.

SPECIFICATION

1. Title of the Invention: DISPLAY DEVICE

2. Claim

A display device in which light emitted from a light source is guided by optical means, and an image formed using liquid crystal light valves is magnified and projected by a projection lens, the display device comprising:

a base which is disposed under the liquid crystal light valves and which covers means for cooling polarizing plates for the liquid crystal light valves; and

guide plates which are used for fixing and adjusting positions of the liquid crystal light valves and which are provided with airflow guiding structures,

wherein vent holes are formed in an upper portion of the base at positions corresponding to the positions at which the airflow guiding structures are formed.

3. Detailed Description of the Invention

[Technical Field of the Invention]

The present invention relates to a projector type display device in which an image formed using liquid crystal light valves is magnified and projected by a projection lens.

[Description of the Related Arts]

Conventionally, a display device including an optical unit, as shown in Fig. 7, which is a side view thereof, is known in the art. This optical unit includes an optical system in which a liquid crystal light valve 3B is attached to a flat guide plate 19B and the guide plate 19B is fixed by a plate 20, which is used for fixing a prism, and a base 21. In addition, cooling means 22 is disposed under the optical system.

[Problems to be Solved by the Invention]

However, in the case in which a blowing-type cooler such as a cooling fan is used as the cooling means in the above-described conventional optical unit, air flows in directions shown by the arrows in Fig. 8. Thus, as is apparent form Fig. 8, although some air flows over the surfaces of polarizing plates attached to the liquid crystal light valves 3B and 3G and cools them, there is a considerable amount of air flowing outward in directions away from the polarizing pates without cooling them. Accordingly, the cooling efficiency is low. In order to increase the cooling ability of this cooling fan, which has such a low cooling efficiency, the size of the cooling fan must be increased. In such a case, the size of the display device is also increased accordingly. In addition, in the case in which the cooling fan having such a low cooling efficiency is used without increasing the size thereof, there is a problem in that it is difficult to emit a high-intensity light beam from the display device due to the low cooling ability.

Accordingly, in order to solve the above-described problems, an object of the present invention is to provide a light, compact display device which emits a high-intensity light beam and in which the cooling ability of a cooling fan is utilized as efficiently as possible. In addition, another object of the present invention is to efficiently cool polarizing plates which are sensitive to heat.

[Means for Solving the Problems]

In order to solve the above-described problems, according to the present invention, a display device, in which light emitted from a light source is guided by optical means and an image formed using liquid crystal light valves is magnified and projected by a projection lens, comprises a base, which is disposed under the liquid crystal light valves and which covers means for cooling polarizing plates for the liquid crystal light valves, and guide plates which are used for fixing and adjusting positions of the liquid crystal light valves and which are provided with airflow guiding structures. Vent holes are formed in an upper portion of the base at positions corresponding to the positions at which the airflow guiding structures are formed.

[Operation]

In the case in which a blowing-type cooler such as a cooling fan is used as the cooling means in the above-described display device, the airflow generated by the cooling fan is collected at the vent holes formed in the base which covers the cooling fan. Then, the airflow is

ejected through the vent holes, guided by the airflow guiding structures of the guide plates, and reaches the surfaces of the polarizing plates for the liquid crystal light valves. Accordingly, the polarizing plates for the liquid crystal light valves can be cooled at maximum efficiency.

[Embodiment]

An embodiment of the present invention will be explained below with reference to the accompanying drawings. Fig. 1 is a plan view showing the basic construction of a display device according to the embodiment of the present invention. With reference to Fig. 1, light emitted from a light source 1 is divided into red, green, and blue light by, for example, a mirror having a selective-reflection characteristic, which is disposed in an optical waveguide 2. The optical waveguide 2 is an example of the optical means. Then, electrooptic modulation of the red, green and blue light is performed by liquid crystal light valves 3R, 3G, and 3B, which correspond to the three colors, respectively. Then, the light is combined by a prism 4, and an image is magnified and projected on a screen disposed in front of the display device by a projection lens 5. In order that the liquid crystal light valves 3R, 3G, and 3B are reliably fixed and adjusted, they are individually attached to guide plates 6R, 6G, and 6B. Each of the guide plates 6R, 6G, and 6B has an opening at the central part thereof and an airflow guiding structure at the lower side thereof. A cooling fan 7 is disposed under the liquid crystal light valves 3R, 3G, and 3B and the prism 4, and cools polarizing plates for the liquid crystal light valves 3R, 3G, and 3B. A

base 8 has a shape such that it can completely cover the cooling fan 7, and vent holes are formed in a top plate of the base 8 at positions corresponding to the positions where the guide plates 6R, 6G, and 6B are disposed (the positions shown by the slanted lines in Fig. 1). Fig. 2 is a side view of the optical unit according to the embodiment of the present invention, and Fig. 3 is a vertical sectional view of Fig. 2 cut along line A-A, which is an optical axis. With reference to Fig. 3, although only the liquid crystal light valve 3R for red light and peripheral structures thereof will be explained below, the following explanations similarly apply to the liquid crystal light valves 3G and 3B for green and blue light, respectively, and peripheral structures thereof. The liquid crystal light valve 3R is fixed to a liquid crystal light valve plate 11R by screws, and the liquid crystal light valve plate 11R is fixed to the guide plate 6R by screws. The guide plate 6R is fixed to an upper plate 14 by screws, and the liquid crystal light valve 3R is thereby retained. In order to display an image, it is necessary that the liquid crystal light valve 3R be disposed between a pair of polarizing plates 12R and 13R. In the present embodiment, the polarizing plate 12R at the incident side of the liquid crystal light valve 3R is laminated on the guide plate 6R at the side facing the prism, and the polarizing plate 13R at the exit side of the liquid crystal light valve 3R is laminated on the prism 4. The guide plate 6R has an opening 15R at the central part thereof and an airflow guiding structure 10R at the lower side thereof. The base 8 not only completely covers the cooling fan 7 but also supports the prism 4 between the upper plate

14 and itself and retains the liquid crystal light valve 3R and the peripheral structures, which are retained by the upper plate 14. In addition, a vent hole 9R is formed in the top plate of the base 8 at the position corresponding to the airflow guiding structure 10R, so that the airflow generated by the cooling fan 7 can be collected at the vent hole 9R. Some of the air which passes through the vent hole 9R flows upward, and the rest of the air flows out away from the rotational center of the cooling fan 7. The air that flows upward passes between the liquid crystal light valve 3R and the polarizing plate 13R and between the liquid crystal light valve 3R and the polarizing plate 12R, so that the surfaces of the polarizing plates 12R and 13R are cooled, and then flows out. In addition, the air that flows away from the cooling fan 7 is guided toward the polarizing plate 12R by the airflow guiding structure 10R, passes through the opening 15R formed at the center of the guide plate 6R, cools the surface of the polarizing plate 12R, which changes the direction of the airflow, and then flows out. Fig. 4 schematically shows the manner in which the air flows. The polarizing plate 12R, which is disposed at the incident side, absorbs 60% of the heat in the light during the polarizing operation, and the surface temperature increases considerably. However, since both surfaces of the polarizing plate 12R are efficiently cooled, degradation of the polarizing characteristics can be prevented. Recently, there are increasing requirements for light, compact display devices which are able to emit a high-intensity light beam. Thus, the display device according to the present invention, in which the polarizing plates for the liquid crystal

light valves are efficiently cooled, is very useful.

In the future, when the weight and size of display devices are further reduced, a thin base 16 shown in Fig. 6 can be used in place of the base 8 shown in Fig. 5. With reference to Fig. 6, a cooling fan 18 is disposed separately from the base 6, which is disposed under the liquid crystal light valves, and airflow generated by the cooling fan 18 is transferred through an airflow guiding duct 17 into the base 16. Also in this case, the air flows in a manner similar to the above-described embodiment, and the weight and the size of the display device can be further reduced.

[Advantages]

As described above, according to the present invention, the basic structure of the conventional optical unit is not changed except that the shape of the base is determined such that the base can cover the cooling fan, the vent holes for collecting the airflow generated by the cooling fan are formed in the base, and the guide plates for fixing and adjusting the liquid crystal light valves are provided with airflow guiding structures, which guide the airflow collected at the vent holes toward the surfaces of the polarizing plates. Accordingly, the cooling ability of the cooling fan is utilized as efficiently as possible, so that the size of the cooling fan can be reduced and a light, compact display device which emits high-intensity light beam can be obtained.

4. Brief Description of the Drawings

Fig. 1 is a diagram showing the basic structure according to an embodiment of the present invention; Fig. 2 is a side view of an optical unit according to the embodiment of the present invention; Fig. 3 is a vertical sectional view of Fig. 2; Fig. 4 is a schematic diagram showing the manner in which air flows; Fig. 5 is a schematic diagram showing a base according to the embodiment of the present invention; Fig. 6 is a diagram of a base and a cooling fan according to a modification of the present invention; Fig. 7 is a side view of a conventional optical unit; and Fig. 8 is a schematic diagram showing the manner in which air flows in the conventional optical unit.

1 ... light source

2 ... optical waveguide

3R, 3G, and 3B ... liquid crystal light valves

4 ... prism

5 ... projection lens

6R, 6G, and 6B ... guide plates

7 ... cooling fan

8 ... base

9R and 9B ... vent holes

10R and 10B ... airflow guiding structures

11R and 11B ... liquid crystal light valve plates

12R and 12B ... incident-side polarizing plates

13R and 13B ... exit-side polarizing plates

14 ... upper plate 14

15R and 15B ... openings

Amendments

1. Claim is amended as described in the attached document.

2. In the specification, "a display device, in which ... the airflow guiding structures are formed.", which is described from the seventh line from the bottom of page 3 to the fifth line of page 4 (in the original Japanese text, from the third line from the bottom of page 3 to the sixth line of page 6), is amended as follows.

"a display device including a light source, liquid crystal light valves which modulate light obtained from the light source, and a projection lens which projects an image formed by the light modulated by the liquid crystal light valves, comprises a base which is disposed under the liquid crystal light valves and which is provided with vent holes for passing airflow therethrough toward the liquid crystal light valves and polarizing plates; and guide plates which are disposed on the base and which are used for fixing the liquid crystal light valves. The guide plates are provided with airflow guiding structures which change the directions of the airflow passing through the vent holes to directions toward the liquid crystal light valves and the polarizing plates."

Claim

A display device including a light source, liquid crystal light valves which modulate light obtained from the light source, and a projection lens which projects an image formed by the light modulated by the liquid crystal light valves, the display device comprising:

a base which is disposed under the liquid crystal light valves and which is provided with vent holes for passing air therethrough toward the liquid crystal light valves and polarizing plates; and

guide plates which are disposed on the base and which are used for fixing the liquid crystal light valves,

wherein the guide plates are provided with airflow guiding structures which change the directions of the airflow passing through the vent holes to directions toward the liquid crystal light valves and the polarizing plates.